RECOVERY AFTER COMPLETE STOPPAGE OF THE HEART FOR FIVE MINUTES

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Many cases have been recorded in which the heart has started beating again after cardiac massage, but the great majority of these have died within forty-eight hours from cerebral symptoms. The case reported below shows, I think, that cardiac massage must be undertaken within a very few minutes of the heart stopping (and the sooner the better) if there is to be any hope of permanent recovery.

Case Record

A male aged 58 years was admitted to the General Hospital, Birmingham, under my care suffering from duodenal ulcer with considerable gastric stasis. After the usual investigation it was decided to do a partial duodenectomy or a posterior gastro-jejunostomy according to the condition found at operation. The anaesthetic was percaine, 16 c.cm., injected between the second and third lumbar vertebrae, preceded by morphine, 1/4 grain, and hyoscine, 1/100 grain. Immediately after the spinal injection 3/4 grain of ephedrine was injected into the muscles of the back. The usual Jones technique was followed.

At the commencement of the operation anaesthesia was perfect, and the patient was breathing quietly, mainly with the diaphragm. His blood pressure had fallen considerably, however, so a second injection of ephedrine, 3/4 grain, was given, and his condition then caused no anxiety, but it was noticed that bleeding from the incision was less than is usual.

Gastro-jejunostomy was selected as the most suitable operation, and everything proceeded normally until the second or inner anastomotic suture was two-thirds completed. The anaesthetist had been a little anxious owing to the shallow breathing and weak pulse, and had given a third dose of ephedrine, but at this point the breathing ceased entirely and the pulse at the wrist could not be felt. The patient made some gaping movements with the mouth and lips such as one frequently sees *in articulo mortis*, and all of those present believed he was dead. There was no corneal reflex, and no pulse could be detected anywhere. I slipped a hand up under the diaphragm and found that the heart had stopped; with my left hand on the front of the chest and my right hand under the diaphragm I could feel what appeared to be an empty flabby heart without a flicker of pulsation. Since no inhalation anaesthetic and no basal anaesthetic had been given, it appeared that the heart must have failed from an excessive fall in blood pressure. The head had, of course, already been lowered and artificial respiration started; strychnine with adrenaline (♏ v) had been given and 2 c.cm. coramine. These measures had no apparent effect, so I continued cardiac massage through the diaphragm while an assistant injected adrenaline (♏ x) directly into the ventricle. I hoped for an immediate response, but it was about a minute later that I felt, for the first time, a faint flicker in the flabby organ I was compressing, so faint that I was hardly sure of it and mentioned it only with diffidence; the look of incredulity had hardly faded from the faces of my assistants when the heart suddenly started beating vigorously at about 120 to the minute.

Artificial respiration was continued while I hurriedly completed the operation. During this period the patient occasionally made the same gaping movements of the lips, "like a fish," which have been mentioned before, but no respiratory movements of any kind were made. It was fully half an hour later that the first faint movement of respiration occurred, and this was only kept going by artificial help and the frequent administration of carbon dioxide.

Two hours later the patient looked like a case of severe concussion, completely unconscious and motionless but with a fair rapid pulse and shallow, almost imperceptible, respirations. Fortunately he retained rectal salines well, and in spite of a temporary collapse ten hours later he was still alive on the following morning. At this period he made slight voluntary movements for the first time, and murmured unintelligibly when spoken to. During this day he had a series of tonic spasms resembling those of tetanus; the limbs and body became rigid and there was even definite opisthotonos.

Forty-eight hours from the operation he spoke intelligibly for the first time and then gradually developed the typical condition of cerebral irritation that one sees after a severe head injury. By the third day an attendant had to be constantly present to keep him from getting out of bed, and it was a week before he could be safely left alone for a moment. Three weeks after the operation he had completely recovered.

Discussion

Time factors are always difficult to estimate in these emergencies. So far as could be ascertained, the pulse and respiration ceased at the same moment, and this would be about fifteen minutes after the commencement of the operation and half an hour after the injection of the percaine. The duration of the heart stoppage is more difficult to determine—I know it was long enough for my fingers to become extremely tired with the cardiac massage, though I removed my hand for a moment while the adrenaline was injected, and my own impression was that the period was eight or ten minutes. One remembers emotions rather than actual intervals on such occasions, and I certainly remember that I had given up all hope at one period and had continued only from a sense of duty rather than with any real hope of success. Other observers put the time at about three to four minutes, and it is of course possible that my natural anxiety may have led me to overestimate the time, though I am personally convinced that it was not less than five. Accepting this figure, the time-table would be approximately as follows:

Zero time.—Injection of percaine.
Fifteen minutes. Operation started.
Thirty minutes.—Respiration ceased. No pulse at wrist. Artificial respiration started.
Thirty-one minutes.—No pulse anywhere: heart stopped as felt through diaphragm. Cardiac massage started.
Thirty-four minutes.—Adrenaline injected into heart.
Thirty-five minutes.—Heart started beating.
Forty minutes.—Gaping movements of mouth and lips.
Forty-five minutes.—Operation concluded.
Sixty minutes.—A faint respiratory movement.
Two hours.—Still complete unconsciousness. Resembled a case of severe concussion.
Twenty-two hours.—First voluntary movements.
Twenty-four to twenty-eight hours.—Series of generalized tonic spasms.
Third day.—Signs of "cerebral irritation."
Fourth to sixth day.—Very noisy and getting out of bed.
Seventh to tenth day.—Gradual restoration to normal mentality.

I do not think that this was a case of respiratory failure from involvement of the phrenic nucleus, for the diaphragm was acting well up to the time when pulse and respiration failed together. Failure was due to an exceptional fall in blood pressure, not counteracted by three doses of ephedrine. The prolonged unconsciousness was presumably due to the effect on the brain of a temporary anaemia, though I like to think that my rhythmic cardiac compression may possibly have kept enough circulation going to save it from irreparable damage. The tonic spasms suggest cortical stimulation from the returning circulation (or recovery of pyramidal cells), and the subsequent period of irritability fits naturally into the picture.